

(19) AUSTRALIAN PATENT OFFICE

(54) Title
Wellbore plug system and method

(51)⁶ International Patent Classification(s)
E21B 7/06 008BMEP
(2006.01) E21B 41/00
E21B 41/00 20060101ALI20051
(2006.01) 008BMEP
E21B 7/06 PCT/US2003/02162
20060101AFI20051 7

(21) Application No: **2003249021** (22) Application Date: **2003.07.11**

(87) WIPO No: **WO04/007898**

(30) Priority Data

(31) Number	(32) Date	(33) Country
10/194,422	2002.07.12	US

(43) Publication Date : **2004.02.02**

(43) Publication Journal Date : **2004.03.18**

(71) Applicant(s)
CDX Gas, L.L.C.

(72) Inventor(s)
Zupanick, Joseph A.

(74) Agent/Attorney
Pizzeyes, Level 2, Woden Plaza Offices, Woden, ACT, 2606

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
22 January 2004 (22.01.2004)

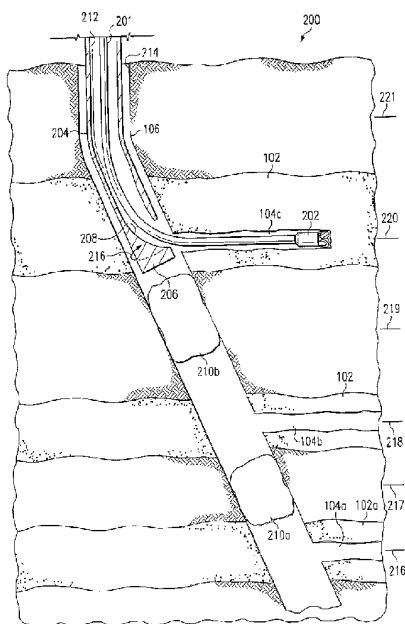
PCT

(10) International Publication Number
WO 2004/007898 A1

- (51) International Patent Classification⁷: E21B 7/06, 41/00 (81) Designated States (*national*): AE, AG, AL, AM, AT (utility model), AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ (utility model), DE (utility model), DK, DM, DZ, EC, EE, ES, FI (utility model), FR, GB, GD, GE, GM, GR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK (utility model), SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW.
- (21) International Application Number: PCT/US2003/021627 (81) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- (22) International Filing Date: 11 July 2003 (11.07.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 10/194,422 12 July 2002 (12.07.2002) US
- (71) Applicant: CDX GAS, L.L.C. [US/US]: 5485 Beldline Road, Suite 280, Dallas, TX 75240-7656 (US).
- (72) Inventor: ZUPANICK, Joseph, A.: Post Office Box 1797, Pineville, WV 24874 (US).
- (74) Agents: STALFORD, Terry et al.: Baker Botts LLP, Suite 600, 2001 Ross Avenue, Dallas, TX 75201-2980 (US).

[Continued on next page]

(54) Title: WELLBORE PLUG SYSTEM AND METHOD



(57) Abstract: In accordance with one embodiment of the present invention, a method for drilling wellbores includes drilling a main wellbore, disposing a casing string having a deflecting member at a lower end thereof in the main wellbore, disposing a drill string having a drill bit at a lower end thereof in the casing string, and drilling, with the drill bit, a first lateral wellbore at a first depth in the main wellbore. The method further includes transferring the casing string to a second depth in the main wellbore that is less than the first depth, disposing a first temporary plug in the main wellbore at the second depth to prevent gas from flowing up the main wellbore past the second depth, transferring the casing string to a third depth in the main wellbore that is less than the second depth, and drilling, with the drill bit, a second lateral wellbore at the third depth.

WO 2004/007898 A1



Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for all designations
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

- with international search report

WELLBORE PLUG SYSTEM AND METHOD

TECHNICAL FIELD OF THE INVENTION

The present invention relates generally to systems and methods for the recovery of subterranean resources and, more particularly, to a wellbore plug system and method.

BACKGROUND OF THE INVENTION

Subterranean deposits of coal (typically referred to as "coal seams") often contain substantial quantities of entrained methane gas. Limited production and use of methane gas from coal seams has occurred for many years because substantial obstacles have frustrated extensive development and use of methane gas deposits in coal seams.

In recent years, various methods have been used to retrieve methane gas deposits from coal seams. One such method is the use of underbalanced drilling using a dual-string technique. As an example of this method, a fluid such as drilling fluid is circulated down a drill string, while another relatively light fluid such as air or nitrogen is circulated down an annulus formed between an outside surface of a drill string and an inside surface of a casing string. A mixture of these fluids is retrieved from an annulus formed between an outer surface of the casing string and an inside surface of the wellbore after mixing with a gas or other fluid obtained from a lateral wellbore being drilled. The purpose of the lighter fluid is to lighten the weight of the drilling fluid such that the hydrostatic head of the

drilling fluid does not force the drilling fluid into the subterranean formation and create detrimental effects.

SUMMARY OF THE INVENTION

5 The present invention provides a wellbore sealing system and method that substantially eliminates or reduces the disadvantages and problems associated with previous systems and methods.

10 In accordance with one embodiment of the present invention, a method for drilling wellbores includes drilling a main wellbore, disposing a casing string having a deflecting member at a lower end thereof in the main wellbore, disposing a drill string having a drill bit at a lower end thereof in the casing string, and
15 drilling, with the drill bit, a first lateral wellbore at a first depth in the main wellbore. The method further includes transferring the casing string to a second depth in the main wellbore that is less than the first depth, disposing a first temporary plug in the main wellbore at
20 the second depth to prevent gas from flowing up the main wellbore past the second depth, transferring the casing string to a third depth in the main wellbore that is less than the second depth, and drilling, with the drill bit, a second lateral wellbore at the third depth.

25 Some embodiments of the present invention may provide one or more technical advantages. These technical advantages may include more efficient drilling and production of methane gas and greater reduction in costs and problems associated with other drilling systems and methods. For example, there may be less damage to
30 lateral wellbores because of mud or other fluids entering a lateral wellbore from the drilling of another lateral

wellbore. In addition, cuttings are prevented from dropping into lower lateral wellbores while an upper lateral wellbore is being drilled. Another technical advantage includes providing a method for killing a lateral wellbore, while still being able to drill another lateral wellbore. An additional technical advantage is that underbalanced drilling may be performed along with the teachings of one embodiment of the present invention.

Other technical advantages of the present invention are readily apparent to one skilled in the art from the figures, descriptions, and claims included herein.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and its advantages, reference is now made to the following description taken in conjunction with the accompanying drawings, wherein like numerals represent like parts, in which:

FIGURE 1 is a cross-sectional view of an example slant well system for production of resources from one or more subterranean zones via one or more lateral wellbores;

FIGURE 2 illustrates an example system for drilling lateral wellbores according to one embodiment of the present invention;

FIGURE 3 illustrates another example system for drilling lateral wellbores according to one embodiment of the present invention; and

FIGURE 4 is a flowchart demonstrating an example method for drilling lateral wellbores according to one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the present invention and their advantages are best understood by referring now to FIGURES 1 through 4 of the drawings, in which like numerals refer to like parts.

FIGURE 1 is a cross-sectional view of an example well system 100 for production of resources from one or more subterranean zones 102 via one or more lateral wellbores 104. In various embodiments described herein, subterranean zone 102 is a coal seam; however, other subterranean formations may be similarly accessed using well system 100 of the present invention to remove and/or produce water, gas, or other fluids. System 100 may also be used for other suitable operations, such as to treat minerals in subterranean zone 102 prior to mining operations, to inject or introduce fluids, gasses, or other substances into subterranean zone 102, or for any other appropriate purposes.

Referring to FIGURE 1, well system 100 includes an entry wellbore 105, a main wellbore 106, a plurality of lateral wellbores 104, a cavity 108 associated with main wellbore 106, and a rat hole 110 associated with main wellbore 106. Entry wellbore 105 extends from a surface 12 towards subterranean zones 102. Entry wellbore 105 is illustrated in FIGURE 1 as being substantially vertical; however, entry wellbore 105 may be formed at any suitable angle relative to surface 12 to accommodate, for example, surface 12 geometries and/or subterranean zone 102 geometries.

Main wellbore 106 extends from the terminus of entry wellbore 105 toward subterranean zones 102, although main wellbore may alternatively extend from any other suitable

portion of entry wellbore 105. Where there are multiple subterranean zones 102 at varying depths, as illustrated in FIGURE 1, main wellbore 106 extends through the subterranean zone 102 closest to surface 12 into and potentially through the deepest subterranean zone 102. There may be one or any number of main wellbores 106. As illustrated, main wellbore 106 is a slant well and, as such, is formed to angle away from entry wellbore 105 at an angle designated α , which may be any suitable angle. Main wellbore 106 may also include cavity 108 and/or rat hole 110 located at a terminus thereof. Main wellbore 106 may include one, both, or neither cavity 108 and rat hole 110.

Lateral wellbores 104 extend from main wellbore 106 into an associated subterranean zone 102. Lateral wellbores 104 are shown in FIGURE 1 to be substantially horizontal; however, lateral wellbores 104 may be formed in other suitable directions off of main wellbore 106 and may have a curvature associated therewith. Any suitable systems and/or methods may be used to drill lateral wellbores 104; however, example systems for drilling lateral wellbores 104 according to various embodiments of the present invention are described below in conjunction with FIGURES 2 and 3.

FIGURE 2 illustrates an example system 200 for drilling lateral wellbores 104 according to one embodiment of the present invention. As illustrated, system 200 includes a drill string 201 having a drill bit 202, a casing string 204, a deflecting member 206 having a deflecting surface 208 coupled to a lower end of casing string 204, and one or more temporary plugs 210 disposed within main wellbore 106.

Drill string 201 may be any suitable drill string having any suitable length and diameter and any suitable drill bit 202 for the purpose of drilling lateral wellbores 104. Drill string 201 is typically a hollow conduit for allowing drilling fluids to flow therethrough. Drill bit 202 may be driven through the use of any suitable motor powered by the drilling fluid or otherwise powered and may have any suitable configuration. To direct drill string 201 and drill bit 202 for the purpose of drilling lateral wellbore 104, deflecting surface 208 of deflecting member 206 is utilized.

Casing string 204 may be any suitable casing string having any suitable diameter that is to be inserted into main wellbore 106. Casing string 204 may be adapted to rotate within main wellbore 106 as illustrated by arrow 216. Although arrow 216 is illustrating a counter-clockwise direction, casing string may also be rotated in a clockwise direction. An inner annulus 212 is formed between the inner surface of casing string 204 and the outer surface of drill string 201. An outer annulus 214 is also formed between an outside surface of casing string 204 and the surface of main wellbore 106. Inner annulus 212, outer annulus 214, and drill string 201 may be used to perform underbalanced drilling. As one example of underbalanced drilling, a first fluid may be circulated down drill string 201, such as drilling mud or other suitable drilling fluids. A second fluid is circulated down inner annulus 212, such as air, nitrogen, or other relatively light fluid. Both first and second fluids may be retrieved from outer annulus 214 after mixing with a gas or other fluid produced from lateral

wellbore 104. The purpose of the second fluid is to lighten the weight of the first fluid such that the hydrostatic head of the first fluid does not force first fluid into the subterranean formation. As a variation, the second fluid may be circulated down outer annulus 214 and the mixture of the first and second fluids along with the gas from lateral wellbore 104 may be retrieved via inner annulus 212.

According to the teachings of the present invention, each temporary plug 210 is adapted to plug main wellbore 106 such that a gas or other fluid existing in main wellbore 106 below temporary plug 210 is prevented from flowing upward past temporary plug 210. In addition, any drilling fluid or cuttings are prevented from flowing down main wellbore 106 past temporary plug 210. In one embodiment of the invention, this allows the drilling of a lateral wellbore 104a in a subterranean zone 102a at a first depth 216 and then the drilling of a lateral wellbore 104b in a subterranean zone 102b at a third depth 218, while ensuring that any gas or other fluid obtained from lateral wellbore 104a at first depth 216 does not flow past a temporary plug 210a existing at a second depth 217 and interfere with the drilling of lateral wellbore 104b at third depth 218.

In one embodiment, temporary plugs 210 are formed from a bentonite clay; however, temporary plugs 210 may be formed from a polymer or other suitable viscous material. In addition, any suitable type of accelerator and/or catalyst may be added to the material that forms temporary plugs 210 in order to speed the curing time of temporary plugs 210 to a suitable time period. Temporary plugs 210 may be other suitable plugs, such as mechanical

plugs, drill plugs, and cement plugs. Each temporary plug 210 may have any suitable length within main wellbore 106. Any suitable system or method may be used to install temporary plugs 210 in main wellbore 106; however, in one embodiment, casing string 204 is utilized to deliver the material down to the desired depth.

In operation of one embodiment of system 200 of FIGURE 2, main wellbore 106 is drilled via any suitable method. Casing string 204 having deflecting member 206 attached thereto is inserted into main wellbore 106. Once at a desired depth, such as first depth 216, drill string 201 having drill bit 202 is inserted within casing string 204 so that lateral wellbore 104a may be drilled at first depth 216. After drilling lateral wellbore 104a, drill bit 202 is retracted from lateral wellbore 104a and casing string 204 is then raised to second depth 217 so that temporary plug 210a may be disposed within main wellbore 106 at second depth 217. The disposing of temporary plug 210a in main wellbore 106 prevents any gas or other fluid produced from lateral wellbore 104a from flowing up main wellbore 106 from a depth below temporary plug 210a past second depth 217. As mentioned previously, this allows successive lateral wellbores 104 to be drilled at successively higher depths while ensuring that any gas or other fluid from a lower lateral wellbore 104 does not cause detrimental effects.

After disposing temporary plug 210a, casing string 204 is transferred to third depth 218 where lateral wellbore 104b is drilled with drill bit 202. After drilling lateral wellbore 104b, drill bit 202 is retracted from lateral wellbore 104b and casing string 204 is then raised to a fourth depth 219 where a

temporary plug 210b is disposed within main wellbore 106. Temporary plug 210b prevents any gas or other fluid from lateral wellbore 104b from flowing up to a depth in main wellbore 106 higher than fourth depth 219. Other lateral wellbores 104, such as a lateral wellbore 104c, may be drilled at higher depths according to a similar procedure as described above.

When the gas or other fluid from all drilled lateral wellbores 104 are desired to be accessed, then each temporary plug 210 that has been disposed within main wellbore 106 may be removed from main wellbore 106 using any suitable procedure, such as drilling. Alternatively, temporary plugs 210 may be removed by their dissolving over a period of time if temporary plugs 210 are formed from a material suitable to dissolve over a period of time. Another example of the use of temporary plugs 210 is shown below in conjunction with FIGURE 3.

FIGURE 3 illustrates another example system 300 for drilling lateral wellbores 104 according to one embodiment in the present invention. System 300 is similar to system 200 described above; however, a difference is that one or more temporary plugs 310 are disposed within each lateral wellbore 104 instead of being disposed within main wellbore 106. Accordingly, when lateral wellbore 104a is drilled at first depth 216, then a temporary plug 310a is disposed within lateral wellbore 104a at a location adjacent to main wellbore 106 to prevent any gas or other liquid from lateral wellbore 104a from flowing into main wellbore 106. Casing string 204 and drill bit 202 may then be raised to third depth 218 so that lateral wellbore 104b may be drilled. After drilling lateral wellbore 104b, a temporary plug 310b is

installed in lateral wellbore 104b at a location adjacent to main wellbore 106. This prevents any gas or other fluid from flowing from lateral wellbore 104b into main wellbore 106b. Successively higher lateral wellbores 104 may be drilled at successively higher depths using similar procedures. Temporary plugs 310 may be installed using any suitable method; however, in one embodiment, the material that forms temporary plugs 310 is pumped down drill string 201. The material that forms temporary plugs 310 may be the same as those described above in conjunction with temporary plugs 210. When gas or other fluid from all lateral wellbores 104 that have been drilled is desired, each temporary plug 310 may be removed using any suitable technique, such as those described above.

FIGURE 4 is a flow chart demonstrating an example method of drilling lateral wellbores 104 according to one embodiment of the present invention. The method begins at step 400 where main wellbore 106 is drilled. Casing string 204 is disposed in main wellbore 106 at step 402. Casing string 204 has deflecting member 206 at a lower end thereof. At step 404, drill string 201 is disposed in casing string 204. Drill string 201 has drill bit 202 at a lower end thereof. At step 406, a first lateral wellbore 104a is drilled from main wellbore 106 at first depth 216. Deflecting surface 208 of deflecting member 206 is utilized to direct drill string 201 in the desired drilling direction.

At step 408, casing string 204 is transferred to second depth 217 in main wellbore 106 that is higher than first depth 216. At step 410, a first temporary plug 210 is disposed within main wellbore 106 at second depth 217

to prevent gas or other fluid from flowing up main wellbore 106 past second depth 217. To facilitate the disposing of first temporary plug 210, drill bit 202 is extracted away from second depth 217. In some
5 embodiments, drill string 201 and drill bit 202 may be completely removed from casing string 204 before disposing first temporary plug 210. As an alternative to disposing first temporary plug 210 in main wellbore 106,
10 first temporary plug 210 may be disposed in lateral wellbore 104a at first depth 216. After disposing first temporary plug 210, casing string 204 is transferred, at step 412, to third depth 218 in main wellbore 106 that is higher than second depth 217.

At step 414, a second lateral wellbore 104a is drilled from main wellbore 106 at third depth 218 with
15 drill bit 202. Because first temporary plug 210 is disposed in main wellbore 106 at second depth 217, second lateral wellbore 104b may be drilled with the assurance that temporary plug 210 will prevent any gas from flowing
20 upward to and past second lateral wellbore 104b.

At step 416, casing string 204 and drill bit 202 are extracted away from third depth 218. First temporary
plug 210 may then be removed, at step 418, so that gas or other fluid may be obtained from lateral wellbores 104a
25 and 104b. In the alternative embodiment where plug 210 is disposed in lateral wellbore 104a, casing string 204 and drill bit 202 do not have to be extracted away from third depth 218.

Although only two lateral wellbores 104a and 104b
30 are drilled in the above described method, other successive lateral wellbores 104 may be drilled at successively higher depths in accordance with the above

method. In this case, there would be a respective
temporary plug 210 disposed within main wellbore 106 at a
depth just above the depth of the respective lateral
wellbore 104, except there does not need to be a
5 temporary plug 210 for the shallowest lateral wellbore
104. In lieu of a slant well system, the described
example method may be used with other suitable well
systems.

10 Although the present invention is described with
several embodiments, various changes and modifications
may be suggested to one skilled in the art. The present
invention intends to encompass such changes and
modifications as they fall within the scope of the
appended claims.

2003249021 23 Oct 2006

What is claimed is:

1. A method for drilling wellbores, comprising:

drilling a main wellbore;

disposing a casing string having a deflecting member at a

5 lower end thereof in the main wellbore;

disposing a drill string having a drill bit at a lower
end thereof in the casing string;

drilling, with the drill bit, a first lateral wellbore at
a first depth in the main wellbore;

0 transferring the casing string to a second depth in the
main wellbore that is less than the first depth;

disposing a first temporary plug in the main wellbore at
the second depth to prevent gas from flowing up the main
wellbore past the second depth without removing the casing

5 string from the main well bore;

transferring the casing string to a third depth in the
main wellbore that is less than the second depth;

drilling, with the drill bit, a second lateral wellbore
at the third depth; and

0 removing the first temporary plug, wherein removing the
first temporary plug comprises either drilling through the
first temporary plug or dissolving the first temporary plug.

2. The method of claim 1, further comprising:

25 transferring the casing string to a fourth depth in the
main wellbore that is less than the third depth;

disposing a second temporary plug in the main wellbore at
the fourth depth to prevent gas from flowing up the main
wellbore past the fourth depth; and

30 drilling, from the main wellbore, a third lateral
wellbore at a fifth depth in the main wellbore that is less
than the fourth depth.

3. The method of claim 1, further comprising: extracting the casing string and the drill bit away from the third depth.

4. The method of claim 1, wherein drilling the main wellbore comprises drilling a slant wellbore.

5. The method of claim 1, wherein the first temporary plug is formed from a material selected from the group consisting of a polymer, a bentonite clay, a mechanical plug, a gel plug, and a cement plug.

6. The method of claim 1, further comprising disposing the casing string in the main wellbore such that an outer annulus is formed between a wall of the main wellbore and an outer wall of the casing string, and disposing the drill string in the casing string such that an inner annulus is formed between an inner wall of the casing string and an outer wall of the drill string.

7. The method of claim 6, further comprising:
circulating a first fluid down an inner passage of the drill string;
circulating a second fluid down the inner annulus; and
retrieving a mixture of the first and second fluids and the gas from the lateral wellbore through the outer annulus.

8. The method of claim 6, further comprising:
circulating a first fluid down an inner passage of the drill string;
circulating a second fluid down the outer annulus; and
retrieving a mixture of the first and second fluids and the gas from the lateral wellbore through the inner annulus.

9. A method for drilling wellbores, comprising:

2003249021 23 Oct 2006

2003249021 23 Oct 2006

drilling a main wellbore; drilling a plurality of lateral wellbores from the main wellbore, the lateral wellbores being drilled at successively lesser depths;

5 disposing a temporary plug in the main wellbore at a depth above the depth of at least one of the lateral wellbores; and

removing the temporary plug after drilling is complete, wherein removing the temporary plug comprises either drilling through or dissolving the temporary plug.

10. The method of claim 9, wherein drilling the main wellbore comprises drilling a slant wellbore.

11. The method of claim 9, wherein each temporary plug is 5 formed from a material selected from the group consisting of a polymer, a bentonite clay, a mechanical plug, a gel plug, and a cement plug.

12. A method for drilling wellbores, comprising:

0 drilling a main wellbore;

disposing a casing string having a deflecting member at a lower end thereof in the main wellbore;

disposing a drill string having a drill bit at a lower end thereof in the casing string;

25 drilling, with the drill bit, a first lateral wellbore at a first depth in the main wellbore;

disposing a first temporary plug in the first lateral wellbore adjacent the main wellbore to prevent gas from flowing from the first lateral wellbore without removing the 30 casing string from the main well bore;

transferring the casing string and the drill bit to a second depth in the main wellbore that is less than the first depth;

drilling, with the drill bit, a second lateral wellbore at the second depth; and

removing the first temporary plug, wherein removing the first temporary plug comprises either drilling through the first temporary plug or dissolving the first temporary plug.

13. The method of claim 12, further comprising:

disposing a second temporary plug in the second lateral wellbore adjacent the main wellbore to prevent gas from flowing from the second lateral wellbore;

transferring the casing string and the drill bit to a third depth in the main wellbore that is less than the second depth; and

drilling, from the main wellbore, a third lateral wellbore at the third depth.

14. The method of claim 12, wherein drilling the main wellbore comprises drilling a slant wellbore.

15. The method of claim 12, wherein the first temporary plug is formed from a material selected from the group consisting of a polymer, a bentonite clay, a mechanical plug, a gel plug, and a cement plug.

16. The method of claim 12, further comprising disposing the casing string in the main wellbore such that an outer annulus is formed between a wall of the main wellbore and an outer wall of the casing string, and disposing the drill string in the casing string such that an inner annulus is formed between an inner wall of the casing string and an outer wall of the drill string.

17. The method of claim 16, further comprising:

2003249021 23 Oct 2006

2003249021 23 Oct 2006

circulating a first fluid down an inner passage of the
drill string;

circulating a second fluid down the inner annulus; and

5 retrieving a mixture of the first and second fluids and
the gas from the lateral wellbore through the outer annulus.

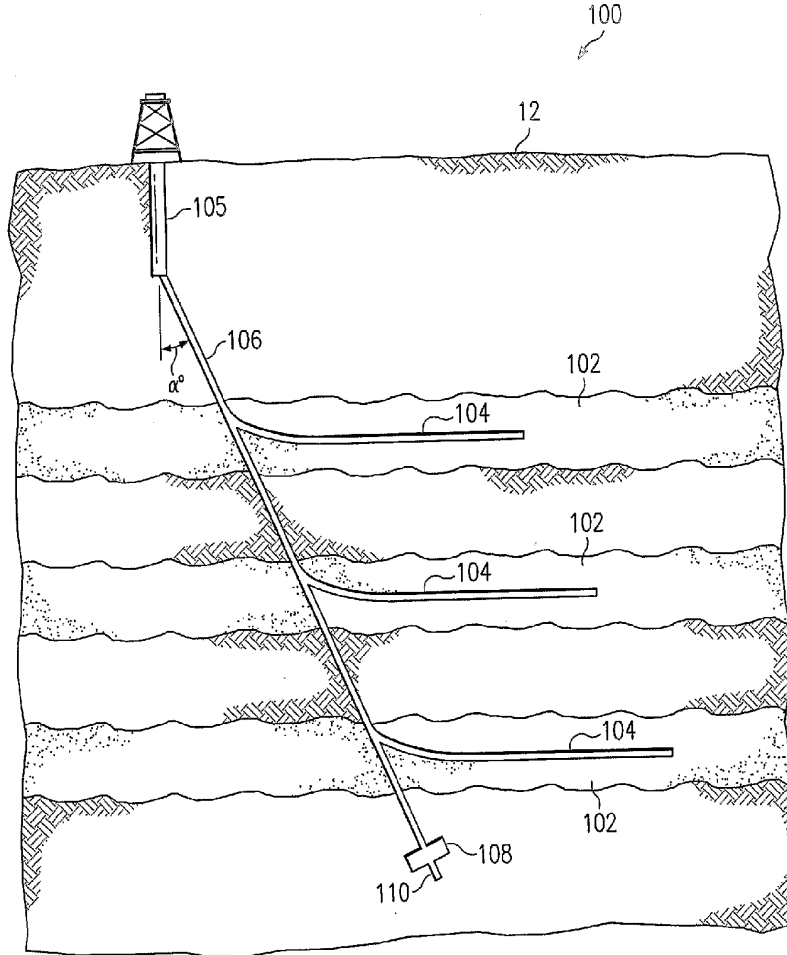


FIG. 1

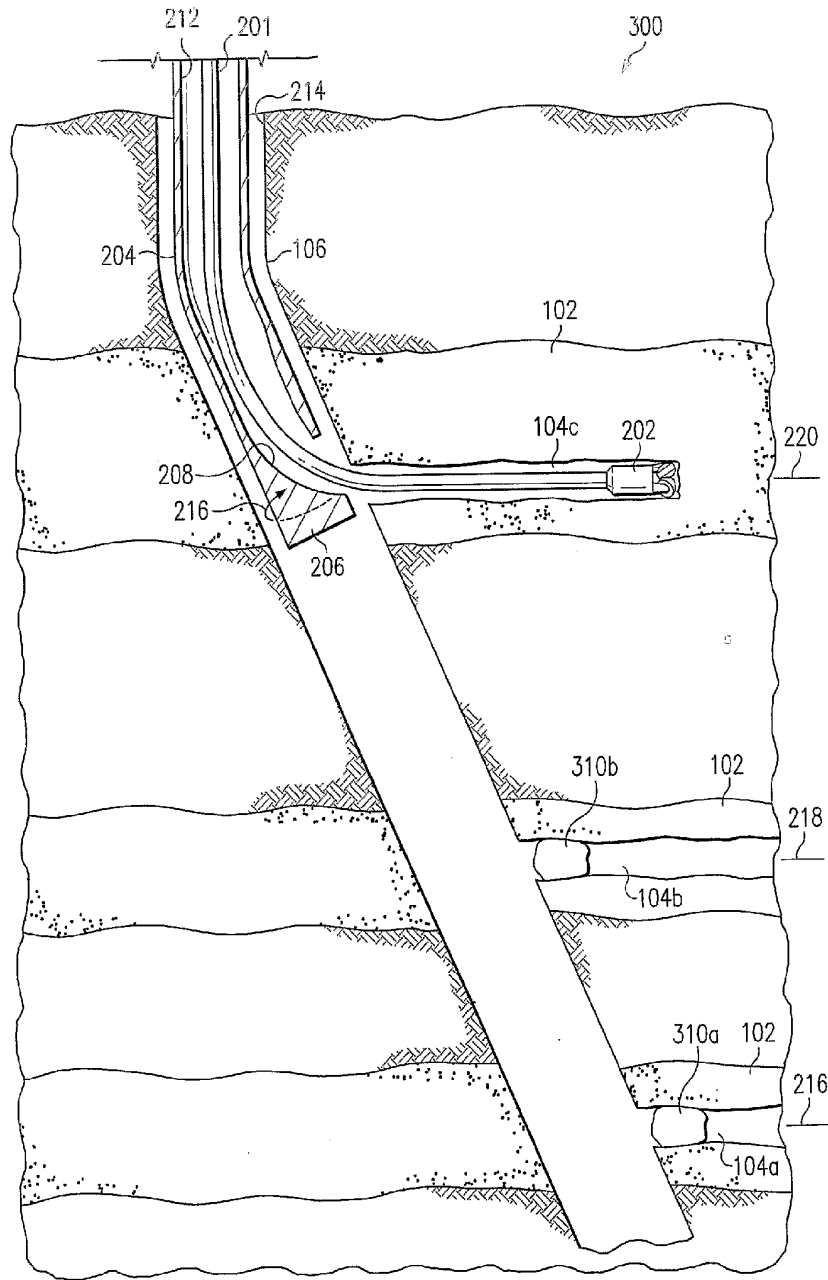


FIG. 3

FIG. 4

